

IN THE SPECIFICATION:

Please amend paragraphs [001], [002], [037], [047], [052], [057], [061] and [068] of the specification as shown below, in which deleted terms are shown with strikethrough and/or double brackets, and added terms are shown with underscoring.

Paragraph [001]

1. Field of the Invention

This invention relates to a method, apparatus and program for compositing images, particularly a computer-graphic image and a picture taken by a camera, and a method, apparatus and program for rendering a three-dimensional model created by computer graphics into a two-dimensional image to be superposed on a picture taken by a camera to form a composite image.

Paragraph [002]

2. Discussion of Background Art

Two-dimensional representation (for on-screen presentation or the like) of a three-dimensional object modeled utilizing a computer (hereinafter referred to as “3D model”) is created by a “rendering” process. Among conventional methods for rendering a 3D model (*i.e.*, generating a two-dimensional image therefrom) is ray tracing, which is disclosed for example in Japanese Laid-Open Patent Application, Publication No. 2000-207576 A. The ray tracing is, as shown in FIG. 5, a method in which a 3D model 101 created in a virtual space on a computer is converted into a two-dimensional image assuming that the object represented by the 3D model 101 is viewed from a specific viewpoint 103. To be more specific, a plane of projection 102 is defined in a specific position of the virtual space on a side of the viewpoint 103 facing toward a

direction in which the 3D model 101 can be seen from the viewpoint 103, for example, between the viewpoint 103 and the 3D model 101; in addition, a light source 104 is set at an appropriate place in the virtual space. In the plane of projection 102 are defined pixels 105 such as those arranged on a screen; a separate light ray 106 for each pixel 105, which is transmitted from the pixel 105 to the viewpoint 103, is traced backward from the viewpoint 103 through the pixel 105 to its origin (3D model 101), or through the 3D model 101 to the pixel 105, so that a color (attributes thereof) of a corresponding portion of the 3D model is assigned to the color of the pixel 105. This operation is performed for every pixel 105, to eventually project the 3D model 101 two-dimensionally on the plane of projection 102.

Paragraph [037]

A detailed description of exemplified embodiments of the present invention will be given with reference to the drawings. First, the optical property of the real-world (“non-pinhole”) camera will be described in which rays of incident light do[[es]] not travel through a single point and thus such distortion in images as could appear in the pinhole camera is eliminated. Next described is calibration data that represents the optical property of the non-pinhole camera in numerical form. Subsequent descriptions will give an idea of a calibration table which includes such calibration data, and illustrate a method of acquiring the calibration data for each pixel of an image taken by a camera to generate the calibration table. Further, a description will be given of apparatuses for compositing images and for rendering an image, which utilizes the calibration table, as exemplary embodiments of the present invention.

Paragraph [047]

[Methods for generating calibration table]

Turning to FIGS. 9A and 9B, a description will be given of a process (method) for generating a calibration table in which calibration data representing in a numerical form the optical property of a non-pinhole camera for each pixel of an image taken by the non-pinhole camera are stored in a correlated manner. FIG. 9A illustrates a conceptual diagram for explaining one exemplary method for acquiring calibration data, in which a ray of incident light is fixed while pan and tilt of a camera are varied. FIG. 9B illustrates a conceptual diagram for explaining another exemplary method for acquiring calibration data, in which a camera is fixed while a ray of incident light is varied.

Paragraph [052]

[Apparatus for compositing images]

Next, an apparatus for compositing images according to one embodiment of the present invention will be discussed in detail with reference to FIGS. 1 and 2. FIG. 1 illustrates a system configuration of the apparatus for compositing images, and FIG. 2 illustrates a rendering process for use in the apparatus as shown in FIG. 1. The apparatus 1 of FIG. 1 is an apparatus for compositing a computer-graphics (CG) image created by rendering a three-dimensional (3D) model and a picture taken by a camera (not shown).

Paragraph [057]

The plane of projection PL is a plane which is located in the virtual space of the computer

and on which a view of the 3D model OB seen from the reference viewpoint O is projected. The plane of projection PL and the reference viewpoint O are defined so that all the lines of sight pass through the plane of projection PL. The projection pixels PP defined on the plane of projection PL are determined to be at positions corresponding to the positions through which lines of sight generated for pixels of a picture taken by the camera. The frame of the projection pixels PP is defined in accordance with the angle (angular field) of view of the camera.

Paragraph [061]

The displacement V_D is a three-dimensional vector from the reference viewpoint O to the displaced viewpoint OP. The reference viewpoint O may be any fixed point in the virtual space of the computer, but may preferably be defined as a point corresponding to an optical center of the camera for convenience' sake. The endpoint of the displacement V_D may be any definite point on the line of sight corresponding to a specific ray of light incident on the camera, and may preferably be defined as a point corresponding to the foot of a line perpendicular to the ray of incident light.

Paragraph [068]

When the dimensions of the image frames have not been adjusted up to that stage, the image frames adjustment operation should precede[[s]] the superposing operation.